Bonneville Power Administration
Fish and Wildlife Program FY99 Proposal

Section 1. General administrative information

Develop Tools To Evaluate The Effects Of Selective Fisheries On Chinook

Bonneville project number, if an ongoing project 9083

Business name of agency, institution or organization requesting funding
National Oceanic and Atmospheric Administration Fisheries

Business acronym (if appropriate) NOAA

Proposal contact person or principal investigator:

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Subcontractors.

Organization	Mailing Address	City, ST Zip	Contact Name
WDFW	600 Capitol Way N.	Olympia, WA 98501	Lee Blankenship
ODFW	2501 S.W. First Avenue, P.O. Box 59	Portland, OR 97207	Don McIsaac, Mike Burner
USFWS	510 Desmond Drive S.E.	Olympia, WA 98503	Ralph Boomer
NWIFC	6730 Martin Way E.	Olympia, WA 98516	Mike Grayum
ADF&G	P.O. Box 25526	Juneau, AK 99802	Norma Sands
University of Washington	Columbia Basin Research, Puget Sound Plaza, 1325 - 4th Ave, Suite 1820	Seattle, WA 98101	James J. Anderson
University of Idaho	Division of Statistics	Moscow, ID 83844	Ken Newman

NPPC Program Measure Number(s) which this project addresses.
8.3A.2, 8.3A.3, 8.3B.1, 8.4D.3, 8.4D.4

NMFS Biological Opinion Number(s) which this project addresses.

Other planning document references.
Snake River Salmon Recovery Plan - Chapter 5, Section 3, Alternative Management Strategies.

Subbasin.

Short description.
Evaluate potential impact of selective fisheries on coastwide chinook management and stock assessment.

Section 2. Key words

Mark	Programmatic Categories	Mark	Activities	Mark	Project Types
X	Anadromous fish		Construction		Watershed
	Resident fish		O & M		Biodiversity/genetics
	Wildlife		Production	X	Population dynamics
	Oceans/estuaries	X	Research		Ecosystems
	Climate		Monitoring/eval.		Flow/survival
	Other		Resource mgmt		Fish disease
			Planning/admin.		Supplementation
			Enforcement		Wildlife habitat enhancement/restoration
			Acquisitions		

Other keywords.
selective harvest, risk, integrated models, ocean conditions

Section 3. Relationships to other Bonneville projects

Project #	Project title/description	Nature of relationship
8910800	Monitoring and Evaluation Modeling Support	Complements this proposal by addressing the effects of oceanic conditions on fish migrations.

Section 4. Objectives, tasks and schedules

Objectives and tasks

Obj 1,2,3	Objective	Task a,b,c	Task
1	Develop a simulation model to predict the effects of selective fisheries for chinook salmon on exploitation rates, management risk, stock rebuilding, and the viability of the CWT system.	a	Develop model specifications.
		b	Write and maintain computer code to implement the model specifications.
		c	Develop methods to estimate parameters for model, including fishery harvest rates and migration rates.
		d	Estimate parameters for model.
2	Develop analytic methods to provide postseason estimates of harvest rates in selective fisheries.		

Objective schedules and costs

Objective #	Start Date mm/yyyy	End Date mm/yyyy	Cost %
1	10/1998	9/2000	80.00%
2	10/1998	9/2000	20.00%
			TOTAL 100.00%

Schedule constraints.

Completion date.
It is anticipated that no funding will be required to achieve the project objectives subsequent to September of 2000.

Section 5. Budget

FY99 budget by line item

Item	Note	FY99
Personnel		
Fringe benefits		
Supplies, materials, non-expendable property		
Operations & maintenance		
Capital acquisitions or improvements (e.g. land, buildings, major equip.)		
PIT tags	# of tags:	
Travel		
Indirect costs		
Subcontracts	Prelimary allocation among subcontracts is as follow: Mgmnt Agencies $16500; UI $52700; UW $120000	$189,200
Other		
TOTAL		$189,200

Outyear costs

Outyear costs	FY2000	FY01	FY02	FY03
Total budget	$250,000			
O&M as % of total	0.00%			

Section 6. Abstract

The Snake River Recovery Plan and the NPPC Fish and Wildlife Program (among many other documents) cite the potential benefits of selective fisheries in reducing fishery impacts on depressed stocks of chinook salmon. However, substantial concerns exist regarding the effects of selective fisheries for chinook salmon on the viability of the coded-wire-tag (CWT) system, management risk, and the cost of fishery management.

The goal of this project is to provide tools for evaluating these concerns, thus providing a common basis for policy decisions regarding the appropriate use of mass marking and selective fisheries for marked chinook salmon. To achieve this goal, it is essential that the tools have the consensus support of all relevant management agencies. This joint proposal is the initial step in the development of a consensus decision. Additionally, an Oversight Committee comprised of representatives of management agencies will direct

development of the analytical tool and participate in the estimation of parameters needed for the analysis.

The analytical methods that we propose are extensions of previous work with coho salmon conducted by the Pacific Salmon Commission and the Columbia River Basin Project. The general methods developed for coho salmon appear to be applicable to chinook salmon, but the complexities of chinook salmon migrations and life history mean that a more complex migration and age structure will be needed. Bimonthly reviews of the project will be completed by the Oversight Committee; model development and parameter estimation will be completed by September of 2000.

Section 7. Project description

a. Technical and/or scientific background.

The FWP and draft Snake River Salmon Recovery plan identify selective fisheries as an alternative method for providing harvest opportunities while reducing fishery impacts on wild stocks of chinook salmon. These topics are discussed further in Section 7 c below.

At least two significant technical impediments exist to the implementation of selective fisheries for chinook salmon marked by the removal of the adipose fin:

> 1) current simulation models cannot accurately assess the effects of mass marking and selective fisheries on the viability of the CWT system, management risk, and the cost of fishery management; and
>
> 2) current analytical methods to estimate fishery specific exploitation rates for total mortality (catch plus incidental mortality) from recoveries of CWTs will provide biased estimates if selective fisheries are implemented.

The goal of this project is to develop tools to remove these impediments, thus providing a common basis for policy decisions regarding the appropriate use of mass marking and selective fisheries for marked chinook salmon.

The fishery simulation models currently available are inadequate to perform the required analyses. Because of the differential fishery harvest rates on marked and unmarked fish and the sampling of the catch for CWTs, a model to evaluate selective fisheries must have a fine time resolution, stochastic algorithms, and mechanisms to simulate the migration of fish through the fisheries. These characteristics are typically absent from the simulation models currently used in fishery management. For example, the chinook model used by the Pacific Salmon Commission (CTC 1997) has neither the time resolution (annual time step), stochastic components (none), or migration algorithms (minimal) necessary to assess the effects of selective fisheries.

A project funded by the NMFS for FY 97 and FY 98 has made substantial progress in the development of 1) a general simulation model with the desired characteristic and 2) statistical models to estimate model parameters. The simulation model (CriSP2) is a derivative of the model developed by the Pacific Salmon Commission to evaluate alternative options for rebuilding chinook salmon stocks. However, the model is undergoing extensive revision by the Columbia Basin Research project to enable improved stochastic modeling of fish migrations and fishery policies.

Methods to estimate the critical migration and harvest rate parameters of the model have only recently been developed for coho salmon (Newman in press). State-space models provide a flexible framework for estimating the abundance of coho salmon by temporal-spatial region using recoveries of CWTs and fishing effort as observables. Model components include the initial spatial abundance of the stock, fishing mortality rates, and movement. Enviromental variables may also be added to the model to evaluate the effects of oceanic conditions on the migration and harvest of salmon stocks. Preliminary results indicate the state-space model works satisfactorily for modeling the coastal migrations of coho salmon. Additional research is required to assess its applicability to the multi-age classes and complex migrations of chinook salmon.

b. **Proposal objectives**.

1) Complete a simulation model that facilitates an evaluation of the effects of selective fisheries on marked chinook salmon on the viability of the CWT system, management risk, and the cost of fishery management.
2) Provide a report that evaluates alternative methods to estimate the parameters for model, including fishery harvest rates and migration rates.
3) Provide a report that documents model algorithms and input data.
4) Provide a draft manuscript suitable for submission to a professional fisheries journal that describes and evaluates alternative methods for estimating harvest rates on unmarked fish in selective fisheries.

c. **Rationale and significance to Regional Programs**.

Planning documents frequently cite the potential benefits of selective fisheries in reducing fishery impacts on depressed stocks of chinook salmon. For example, the FWP states "To speed the rate at which weak stocks rebuild and provide opportunities to harvest over the long term in the Columbia River, it is essential that development and evaluation of live-catch fishing technologies and known-stock fisheries be started immediately" (section 8.3). Similarly, the draft Snake River Salmon Recovery Plan states "NMFS agrees that selective and terminal area fisheries offer the best opportunities to ameliorate the effects of these management controls" and "There are many technical problems and social implications associated with developing the various selective fishery options. Many proposals will prove impractical. NMFS will support the research and development of viable options..." (NMFS 1995).

One type of selective fishery currently under consideration by many fishery management agencies relies upon mass marking chinook salmon of hatchery origin by removing the adipose fin. In subsequent fisheries, only fish that do not have an adipose fin may be retained. Fish with an adipose fin (primarily of wild origin) are released, providing the potential for reduced fishery impacts on the less productive wild stocks.

Fishery impacts on coho and chinook salmon are currently estimated from recoveries of coded-wire-tags (CWT). The recoveries of CWTs are a central, essential component of the management of coho and chinook salmon, and currently provide the only means to estimate catch distributions, survival rates, and exploitation rates (ASFEC 1995). To maximize the value of CWTs, most management agencies have identified a set of indicator stocks that are tagged annually. Under the assumption that the tagged and untagged fish have similar patterns of distribution and exploitation, statistics estimated for the indicator stocks are applied subsequently in the management of the associated untagged fish.

The importance of the CWT to management is underscored by the inclusion within the Pacific Salmon Treaty (and associated Memorandum of Understanding) provisions requiring the maintenance of the CWT program. The Pacific Salmon Commission also established in 1993 a committee to evaluate the effects of mass marking and selective fisheries. For **coho salmon**, the committee (ASFEC 1995) concluded that “the viability of the CWT program could be impaired if selective fisheries are implemented on a broad scale”, where viability was defined as:

> 1) the ability to use CWT data for assessment and management of wild stocks of chinook and coho salmon;
>
> 2) the ability to maintain the program such that the uncertainty in our assessments and their applications does not unacceptably increase management risk; and
>
> 3) the ability to estimate stock-specific exploitation rates by fishery and age.

This conclusion was based on two observations: 1) exploitation rates of tagged and marked fish are no longer representative of the exploitation rates on unmarked and untagged fish since unmarked fish cannot be retained in the selective fishery; and 2) the incidental mortalities of unmarked fish in selective fisheries cannot be directly estimated from the recoveries of tagged and marked fish as the ratio of marked to unmarked changes as a result of selective fisheries (ASFEC 1995).

The ASFEC also developed tagging (double index tagging) and analytical procedures for coho salmon to minimize the information loss. However, the applicability of these procedures to chinook salmon is uncertain, and the committee was unable to develop methods that would provide estimates of fishery specific mortalities on unmarked stocks when multiple selective fisheries occur (Section 24, Objective 2 of this proposal).

The ASFEC (1995) did not evaluate the effects of selective fisheries and mass marking on chinook salmon, stating that “selective fishery options for chinook salmon are considerably more difficult to assess than for coho salmon because of the greater complexity of the chinook salmon life history, variable release mortality rates for different age chinook salmon, and the more extensive ocean migration of individual chinook salmon stocks resulting in impacts on more fisheries and stock assessment programs. Further, the technology is not currently available to mass mark large numbers of chinook salmon in a short period of time, or to electronically detect CWTs, the preferred method for coho salmon, in large-bodies individuals.”

One impediment mentioned by the ASFEC, the inability to remove the adipose fin from large numbers of fish in a short period of time, has nearly been surmounted. Under a proposal submitted by WDFW, the BPA Fish and Wildlife Program has funded the development of a machine that automates the removal of the adipose fin on about 50,000 chinook per 8 hour period. Machine marking of chinook salmon could become fully operational for the 1998 brood.

Automation of the removal of the adipose fin may now make mass marking of chinook salmon feasible, but analytic tools are needed to assess the potential impacts of mass marking and selective fisheries on the viability of the CWT program and the cost of fishery management. Unfortunately, the fishery simulation models currently available cannot be used to perform this analysis

Some management agencies have indicated a reluctance to initiate mass marking and selective fisheries for chinook salmon until these technical limitations are addressed. This project provides the funding and collaborative structure required to address this concern.

The NPPC Fish and Wildlife Program identifies the development of such tools in sections 8.3A and 8.3B. Specifically:

> 8.3A.2 Fund the fishery managers and fishers to evaluate the feasibility of live-catch fishing technologies and known stock fisheries…
>
> 8.3A.3 Share the cost on a 50/50 or other mutually agreed basis for the needed research and model development to improve accuracy and precision.
>
> 8.3B.1 Fund pilot project to demonstrate the feasibility of various methods to selectively harvest abundant stocks while conserving seak stocks.
>
> 8.4D.3 Identify and implement research and model refinements needed to improve pre-season and inseason estimates of abundance and fishery impacts…

8.4D. 4 Share the costs on a 50/50 or mutually agreed basis for the needed research and model development to improve accuracy and precision.

With regard to cost sharing, NOAA Fisheries has previously provided two years of seed funding for this project.

A complementary project (Monitoring and Evaluation Modeling Support, project 8910800) will concurrently expand the utility of the simulation model by linking ocean climatic conditions to the survival rates and distribution of salmon stocks. The combined projects thus address Congressional directives to consider oceanic conditions in the development of recovery plans for listed species.

d. Project history

This is a new project.

e. Methods.

Objective 1. Simulation Model. Development of the simulation model will be directed by an interagency committee comprised of experts in the fields of biometrics, simulation modeling, and fisheries management. The model will be developed in an object oriented environment, providing the capability to develop and improve each class of object independently.

Objective 2.   Parameter Estimation Methodology. Parameters for the simulation model will be estimated using a multivariate, linear normal state-space model (SSM). Using recoveries of CWTs and fishing effort, a Kalman filter will be used to estimate the parameters of the underlying migration and harvest processes (Newman in press).

Objective 3. Parameter Estimation. Parameter estimates for chinook stocks on the west coast of North America will be estimated by management agency personnel using the methodology developed in Objective 2.

Objective 4. Postseason Estimates of Harvest Rates. The utility of the SSM and other models (ASFEC 1995) for estimating harvest rates on unmarked fish in selective fisheries will be evaluated.

It should be recognized that these objectives may be difficult to achieve. Estimation of chinook salmon migration and fishery harvest rates is an extremely complex task, and appropriate estimation methods are only now being developed. Failure to achieve these objectives may, in a sense, also be considered a positive result. In such a case, the project would provide a common technical understanding of the risks and costs of selective fisheries.

f. **Facilities and equipment**.

This project will be completed at the existing facilities of fishery management agencies, the University of Washington, and the University of Idaho.

g. **References**.

ASFEC (Ad-hoc Selective Fishery Evaluation Committee). 1995. Pacific Salmon Commission selective fishery evaluation. Pacific Salmon Commission, Vancouver, British Columbia, Canada.

CTC (Chinook Technical Committee). 1997. Description of calibration procedures & results of May 1997 calibration of the PSC chinook model. TCCHINOOK(97)-2. Pacific Salmon Commission, Vancouver, British Columbia, Canada.

Newman, K. In press. State-space modeling of animal movement and mortality with application to salmon. Biometrics.

NMFS. 1995. Proposed recovery plan for Snake River salmon. U.S. Department of Commerce.

Section 8. Relationships to other projects

This proposal is a collaborative project of NOAA Fisheries, ADF&G, WDFW, NWIFC, USFWS, ODFW, University of Washington, and the University of Idaho. The proposal proponents recognize that the scope and importance of this project necessitates increased coordination and interaction between technical staffs of the management agencies and research scientists. Only through such a collaborative effort will the difficult tasks addressed by this project be accomplished.

Section 9. Key personnel

James B. Scott, Jr. Fish Population Dynamics Modeler, NOAA Fisheries. 0.10 FTE. Project coordinator. Mr. Scott is co-chair of the Pacific Salmon Commission Chinook Technical Committee and was a member of the Steering Committee of the Ad-hoc Selective Fisheries Evaluation Committee. His time will be provided by NOAA Fisheries for this project at no cost.

James J. Anderson. 1.0 FTE Associate professor in the School of Fisheries and Graduate Program in Quantitative Ecology and Resource Management at the University of Washington. Principle Investigator. Dr. Anderson heads the Columbia River Salmon Project at the University of Washington School of Fisheries. This is a multi-year effort that has developed the CRiSP passage model and the CRiSP harvest model.

Ken Newman. Assistant professor in the Division of Statistics at the University of Idaho. Principal Investigator. 0.25 FTE. Dr. Newman has been a principal investigator in a project funded by the NMFS to develop methods to estimate ocean migration rates for coho salmon.

Section 10. Information/technology transfer

1) The simulation model will be available on a WEB site and distributed to PSC technical committees, the Salmon Technical Team of the Pacific Management Council, and management agencies.
2) Results from the project will be disseminated in the reports discussed in Section 7.
3) In conjunction with the PSC, workshops will be held discussing the results of the project and potential implication for fisheries management.